Chip Mill Report

DRAFT REPORT ON THE CHIP MILL ISSUE (html version)

Missouri Department of Conservation's DRAFT report on the chip mill issue in Missouri. This report has not been finalized and has not yet been accepted by the Conservation Departments Director or the Conservation Commission.

NOTE: This html document provides you with the entire report. Due to limitations of web page displays, the pages listed in the table of contents will not exactly match the numbering of pages in any printout you

DRAFT REPORT ON THE CHIP MILL ISSUE

submitted to

Jerry Conley and John Smith

by

Lynn Barnickol, Forestry Division
Brian Brookshire, Forestry Division
Dick Duchrow, Fisheries Research
Jane Epperson, Administrative Services Division
Shelby Jones, Forestry Division
Bruce Palmer, Outreach and Education Division
Russ Titus, Wildlife Division
Tom Treiman, Forestry Division
David Urich, Natural History Section

Table of Contents

Page Number

Attachment A Sustainable Forestry for Tomorrow's World
Attachment B Professional Timber Harvester Program Brochure
Attachment C Missouri Watershed Protection Practice
Attachment D How Healthy Are Your Trees Brochure

EXECUTIVE SUMMARY

A chip mill mechanically reduces trees and tree parts to chips that are roughly one square inch. Chips are then transported to a separate regional or national facility where they are processed primarily into pulp and ultimately paper.

A chip mill itself does not impact Missouri's forests directly; rather, potential impacts stem from the nature and extent of logging on forest land in response to the chip market. Mill representatives contract with loggers, generally within a 100-mile radius of the mill, to purchase wood for chip production.

The occurrence of chip mills has increased in the southeastern United States in the past decade. In 1996, wood on an estimated 1.2 million acres of forest land was harvested to supply 140 chip mills in the Southeast (Smith 1997). The number of chip mills and associated wood harvest volumes reveal potential for forest impact. Since the 1960s, two chip mills have been using wood from Missouri, and presently three chip mills are located in the state.

A nine member technical committee of the Missouri Department of Conservation (MDC) considered the environmental and economic effects of the three chip mills operating in Missouri.**CONCLUSIONS**

> Natural resources and the extent and manner of timber harvesting, primarily on private land, constitute the "chip mill issue" in Missouri, not the chip mills themselves.

> If private forest owners use voluntary best management practices (BMPs) for timber harvest (Missouri Department of Conservation 1997) and regional annual harvest does not exceed regional annual growth, Missouri's forest resources can support a chip mill industry.

> Landowner surveys reveal that most private forest owners have never consulted a professional forester, and fewer still have had a forest plan written for their properties. Acknowledging that BMPs are voluntary, there is potential that any resultant increase in harvesting to support chip mills will result in increased runoff, sediment transport, nutrient leaching, and increased stream temperatures during the first few years following harvest.

> Without a mechanism to accurately document and track timber harvest practices, we will remain unaware of the extent to which BMPs are being used on private land, and will lack theability to monitor any short-term changes in forest resources attributable to the chip industry.

> Age composition of private forests could change from one with a balance of mature and young trees to one with primarily immature trees if landowners meet the chip mill market by harvesting all stock as soon as it's marketable--in this case, progressively younger stock.

> Given the lack of landowner support for the state regulation of private forest land, effort should be increased on implementing existing private forest assistance programs and developing new incentive programs to conserve Missouri's forests.

DRAFT POSITION STATEMENT

Chip mills exist because there is a market demand for paper products. The environmental impact of forest product industries in Missouri depends on whether best management practices (BMPs) are used during harvest

and the total volume of wood harvested. Surveys indicate that most private forest owners do not consult a professional forester. Likely, BMPs are not being employed on the majority of private forest lands. MDC recommends that a coordinated, statewide effort be focused on dramatically increasing the technical assistance and incentive programs which would result in the effective use and monitoring of BMPs on private forest land. To accomplish this task MDC will participate in the development of an incentive, technical assistance and legislative package to assist private landowners with forest management.

RECOMMENDED ACTIONS

1. Adopt (in 1999) an MDC policy (to take effect in 2000) that requires loggers who purchase timber on MDC land to implement and document use of BMPs and make it a prerequisite for the logger to have successfully completed the Professional Timber Harvester (or equivalent) Program. During the next year, work with industry to explain the policy and offer assistance in fulfilling requirements.

2. Encourage policies by timber companies in Missouri to require, track and document the successful use of BMPs on land where wood fiber is purchased, and require that their contract loggers successfully complete the Professional Timber Harvester (or equivalent) Program.

3. Request that the Missouri Forest Products Association and other forest interests increase the emphasis placed on BMPs in the Professional Timber Harvester Program.

4. Commit the funds necessary to double the sampling intensity for the Ozark and River Border units of the Forest Inventory Analysis.

5. Propose an amendment to the State Forestry Law that would sunset the Forest Cropland Program and, in its place, create a new, more effective and attractive program to increase landowner participation in appropriate forest management.

6. Develop and propose an amendment to the State Forestry Law that would require landowners to notify MDC of pending commercial harvest of 20 acres or more and give MDC foresters the right to inspect. The proposed amendment would create a yield tax that would be distributed back to the landowners for implementation of stewardship plan objectives and best management practices.

7. Create a pilot project that focuses on the overlapping procurement zone for the Mill Spring and Scott City chip mills where MDC would proactively encourage the development of stewardship plans for cooperating landowners.

8. Support research funding to investigate potential water quality concerns and socioeconomic impacts within the sourcing areas of the Mill Spring and Scott City chip mills.

9. Seek out on-the-ground examples of good forest management practices by private landowners that have utilized the chip market and use them for demonstration purposes to encourage other private landowners.

SUPPORTING INFORMATION

Demand for Wood Products

Demand for wood and wood fiber continues to increase worldwide. Missouri's wood products industry is a manufacturing leader in hardwood lumber, tight cooperage, pallets, railroad ties, handles, hardwood flooring, fancy gun stocks, industrial charcoal, briquette charcoal, and specialty wood products such as cedar bowls. The 1994 Timber Products Output, based on a government survey, shows the Missouri industry to have processed approximately 709 million board feet of timber. Employment associated with the wood products industry is approximately 33,000 persons, supporting 2,500 firms, contributing about $3 billion annually to Missouri's economy.

Processing of Missouri forests began with settlement in the late 1790's. Peak harvest occurred in the Ozarks during the period of 1880 to 1920, when shortleaf pine and later hardwoods were cut during the United States' westward expansion and industrial revolution. A slowdown in wood processing extended from 1920 through 1945 when land was cleared for expanding agriculture markets. Uncontrolled fires were frequently set to create pasture, resulting in damage to many trees. The modern era of forest conservation in Missouri traces its roots to the 1930s, marked by a slow reduction in wild fires, focus on soil retention, and emphasis on private forest stewardship.

Missouri's contemporary forest is essentially second generation with the exception of a few remnant stands of trees found on Conservation Department Natural Areas, State Parks, Mark Twain National Forest Wilderness Areas, Pioneer Forest and a few other privately owned tracts.

Raw Wood to Chips to Pulpwood

In Missouri, trees with high commercial value yield veneer, lumber, railroad ties, and pallets. Trees with low commercial value in the same tract represent potential chips and ultimately pulpwood. A chip mill is capable of producing 300,000 tons of chips per year; by comparison, one lumber-producing sawmill is capable of producing 24,000 to 32,000 tons per year.

Pulpwood characteristically comes from two sources:

(1) Trees left in the woods following a commercial cut because the logger has no economic incentive to take them, and

(2) Residue from wood harvested and sawed for blocking and pallet lumber.

Pulpwood can be generated from clearcuts or selection cuts, both scientifically sound practices in the Missouri Ozarks when properly applied.

Obtaining permits for a new pulp and paper plant in the U.S. is difficult. Existing plants, however, can expand by establishing satellite chip mills which transport chips to existing pulping facilities.

Some equate the chip mill with a market for trees with lower commercial value. In fact, trees of low or no commercial value often are cut prior to commercial harvest and left to deteriorate to minimize competition with healthy, vigorously growing trees, a practice called "timber stand improvement". Live hollow trees, "den trees," and "snags" are frequently left standing to provide wildlife habitat.

Chip Mills in Missouri

Since the 1960s, Westvaco Corporation has operated a chip mill, pulp mill, and fine-paper facility at Wyckliffe,

KY. The wood-source area included several counties in southeast Missouri, with a log shipping yard located at Leeper, MO. Although the Leeper yard was abandoned in the late 1980s, Westvaco continues to purchase sawmill residues from Missouri mills.

Ft. Madison Paper Company, Ft. Madison, IA, has also operated a chip mill, pulpmill and corrugated box plant since the 1960's, with a source area in several northeast Missouri counties.

Three chip mills currently operate in Missouri:

(1) Willamette Industries, Incorporated of Portland, Oregon, owns the Mill Spring Chip Plant on Highway 49 in Mill Spring, Wayne County. The Mill Spring Chip Plant has authority to debark and produce 300,000 tons of wood chips per year. After temporary storage, chips are moved by train and truck to Willamette's Kentucky paper mill. Willamette Industries recently upgraded its fine-papers plant in Hawesville, KY. Wood stock is within cost-effective transportation range of the Hawesville facility. (DNR, Permit # 0197-009)

(2) Canal Chip Corporation of St. Simons Island, Georgia owns the Missouri Fibre Corporation Chip Mill, on Nash Road, SEMO Port, Scott City, Scott County. The Missouri Fibre Corporation Chip Mill is located on 35 acres and has authority to debark and produce 300,000 tons of wood chips per year. The mill receives pine and hardwood logs that are stored in a wet decking area, stored around the rotary crane, or placed directly in the debarker. Resulting wood chips are shipped off-site for further processing. Canal Corporation is here partly for accessing Missouri's forest resource and for shipping access on the Mississippi River. (DNR, Permit # 0997-012)

(3) Ozark Wood Products Company, Incorporated owns the chip mill facility at U.S. Hwy 71 and Hwy C near Goodman, in McDonald County. Annual capacity and acreage of the facility is unknown. Currently, the Ozark Wood Products Company utilizes only sawmill residues (no roundwood), so present forest impacts are negligible.

Willamette, Canal and Westvaco are all members of the American Forest and Paper Association which requires those companies to adhere to the standards developed by the Sustainable Forestry Initiative Program. Those standards include: following BMPs developed by individual states, encouraging the purchase of logs from loggers who have attended training, minimizing the size of clearcuts and dispersing clearcuts, among others. Attachment A is a report on the Sustainable Forestry Initiative Program.

Existing Regulations

No Missouri law regulates timber harvest methods or the amount of wood harvested on private land. A chip mill facility, however, is regulated by the Missouri Department of Natural Resources (DNR) under existing water and air pollution laws and regulations.

National Pollution Discharge Elimination System (NPDES). Any facility whose Standard Industrial Classification (SIC) code begins with "24" (includes saw and chip mills) is regulated as a potential point source pollution discharger under the NPDES for Stormwater.

A NPDES stormwater permit has been issued for each of Missouri's three chip mills. The Goodman (McDonald Co) and Mill Spring Chip Plant (Wayne Co) mills were issued General Permits which are effective for five years.

The General Permit for primary processors of wood and forest products is currently under revision. A General Permit currently requires that discharges be above a pH of 6. The proposed permit (1) sets a tonnage or board foot limit, (2) requires annual storm water sampling, (3) requires quarterly dry weather sampling, (4) sets effluent limits, and (5) requires best management practices for timber harvest.

The Missouri Fibre Corporation Chip Mill required a Site Specific Permit because it uses a "wet decking

process" in which water from a basin is sprayed on stored logs to reduce insect damage. This process is considered a categorical discharge that requires an Site Specific NPDES permit. Willamette has recently applied for a Site Specific Permit for their Mill Spring Chip Plant.

Air Pollution Control (APC). Depending upon site specific processors of a chip mill (e.g. chipper, sawmill, boilers, conveyors, blowers, pulpers, etc.) an APC permit may be required.

APC permits have been issued for the Missouri Fibre Corporation Chip Mill (Scott and Cape Girardeau Counties) and the Mill Spring Chip Plant (Wayne County). Both are considered "de minimis" permits (the smallest construction permit category), meaning that processes result in less than 15 tons of particulates, less than 10 microns in size, per year. If a chip mill encloses their operations (further controlling their emissions) in a building or warehouse, an APC permit may not be required at all. The APC regulations are set up to control the emission of particles that effect human health, welfare or the environment, therefore, one inch wood chips are not a big concern.

In addition to the NPDES and APC permitting requirements, timber harvesting activities that may impact waterbodies are subject to the *Missouri Clean Water Law, Water Quality Standards* (10 CSR20-7.031)(4).

The Specific Criteria (4) shall apply to classified waters...

(D) Temperature.

1. For general and limited warm-water fisheries beyond the mixing zone, water contaminant sources and physical alteration of the water course shall not raise or lower the temperature of a stream more than five degrees Fahrenheit (5F). Water contaminant sources shall not cause or contribute to stream temperature in excess of ninety degrees Fahrenheit (90F)...

2. For cool-water fisheries beyond the mixing zone, water contaminant sources and physical alteration of the water course shall not raise or lower the temperature of a stream more than five degrees Fahrenheit (5F). Water contaminant sources shall not cause or contribute to stream temperature in excess of eighty-four degrees Fahrenheit (84F).

3. For cold-water fisheries beyond the mixing zone, water contaminant sources and physical alteration of the water course shall not raise or lower the temperature of the water body more than two degrees Fahrenheit (2F). Water contaminant sources shall not cause or contribute to stream temperature in excess of sixty-eight degrees Fahrenheit (68F).

(G) Turbidity and Color. Water contaminants shall not cause or contribute to turbidity or color that will cause substantial visible contrast with the natural appearance of the stream or lake or interfere with beneficial uses.

(H) Solids. Water contaminants shall not cause or contribute to solids in excess of a level that will interfere with beneficial uses. The stream or lake bottom shall be free of materials, which will adversely alter the composition of the benthos, interfere with the spawning of fish or development of their eggs or adversely change the physical or chemical nature of the bottom.

(Q) Biocriteria. The biological integrity of waters, as measured by lists or numeric diversity indices of benthic invertebrates, fish, algae or other appropriate biological indicator, shall not be significantly different from reference waters..."

To date, timber harvesting in Missouri has not resulted in a violation of the *Missouri Clean Water Law*.

Ellefson et al. (1995) compiled information regarding the regulation of private forestry practices by state governments. Ten states have comprehensive forest practices regulatory programs: Alaska, California, Connecticut, Idaho, Maine, Massachusetts, Nevada, New Mexico, Oregon, and Washington. The legislative intent of these laws is to protect forest soils, fisheries, wildlife, water quality and quantity, air quality, recreation, and scenic beauty, while maintaining a healthy wood-based industry. Non-residents proposing to harvest timber from private forest land in Idaho must submit a bond of at least $5,000 prior to operations. In addition to a timber harvest permit, performance bonds are also required of landowners in Nevada. In Maine, clearcuts of 50 acres or more require preparation and submission of a timber harvesting plan. Commercial harvesters must also report information on volume cut, stumpage price, species cut, location of harvesting, area of land harvested, harvest methods employed, and extent of whole-tree harvesting for solid and chipped wood. For the most part, forest practice rules are prescribed by nature. For example, Idaho's rule states: on slopes exceeding 45 percent gradient and which are immediately adjacent to a class I or II stream, tractor wheel skidding shall not be conducted unless the operation can be done without causing accelerated erosion... Other examples include no clear-cut unit shall exceed 120 acres, leave at least 50 trees of at least 11 at diameter breast height (dbh) within visually sensitive corridors, limit forest practices along designated scenic highways.... In the ten states that administer comprehensive forest practices programs, the administration accounted for about 4 percent of the total forestry budget. Costs of forest practice regulation varies by state but ranges from an estimated $685,000 in Idaho, or 4.3 percent of the agency $15.9 million budget, $8.1 million or 25 percent of the California Forestry $400 million budget, to $560,000, or 40 percent of Massachusetts $1.4 million budget. The Maryland regulatory program costs approximately $1.3 million, while Virginia's voluntary program costs approximately $800,000 annually.

In addition to regulatory programs, a National Association of State Foresters Survey shows that 36 states, primarily the South and Midwest, have voluntary forest practice act requirements. Many states use a forest practice act guidebook to communicate guidelines to industry and landowners. Missouri has a publication entitled *Missouri Watershed Protection Practices* (1997) by the Missouri Department of Conservation. Like the other states, Missouri guidelines target the logging road system with recommended practices, called best management practices (BMPs), for reducing sediment transport from roads and encouraging the use of buffer strips of undisturbed land along streams as methods to reduce sediment transport to streams (Boyette 1993).

Forest Resource Analysis

According to the most recent statewide forest inventory, Missouri has 14 million acres of forest land, 13.3 million of which (95%) are classified as "timberland" (Spencer et al. 1989). Timberland is that portion of the total forest resource capable of producing at least 20 cubic feet of wood fiber per acre per year.

The majority of Missouri's timberland is in the South. The 18 county area, identified in Figure 1, has been selected for discussion because it approximates the Missouri-portion of the wood-source area for two of Missouri's three chip mills.

In the 18 county area there are 3,397,700 acres of timberland. This acreage is approximately 47% of the total land area in the 18 counties. The timberland category does not include state and federal reserved forest lands, such as state parks and U.S. Forest Service wilderness areas, where no timber harvest can occur. The timberland category does include, however, private forest lands in which landowners could choose not to harvest. Timberland ownership in the 18 county area is about 67% private, 22% federal, 6% state and 5% industry.

Forest Inventory and Analysis (1989) and Timber Products Output Survey (1994) data, shown in Table 2, are summarized here in Table 1.

Table 1 Summary of Available Hardwood Resource in the 18 County Sourcing Area

Potential Source	Million Cubic Feet	Tons

Balance of growing stock	17.4	542,162
50% of harvest residues	16.8	525,408
Rough annual growth	18.1	564,564
Mill residue		373,020
TOTAL		2,005,154

The total potential forest resource that is available for chip mill utilization is approximately 2 million tons. This total represents what is available without cutting any
growing stock. Assuming that the three Missouri chip mills reach their full production capacity, they would produce 680,000 tons per year, or 34% of the 2 million tons available.

Figure 1 Chip Mill Procurement Zones: 50 Mile Radius Around Mill Spring and 75 Mile Radius Around Scott City

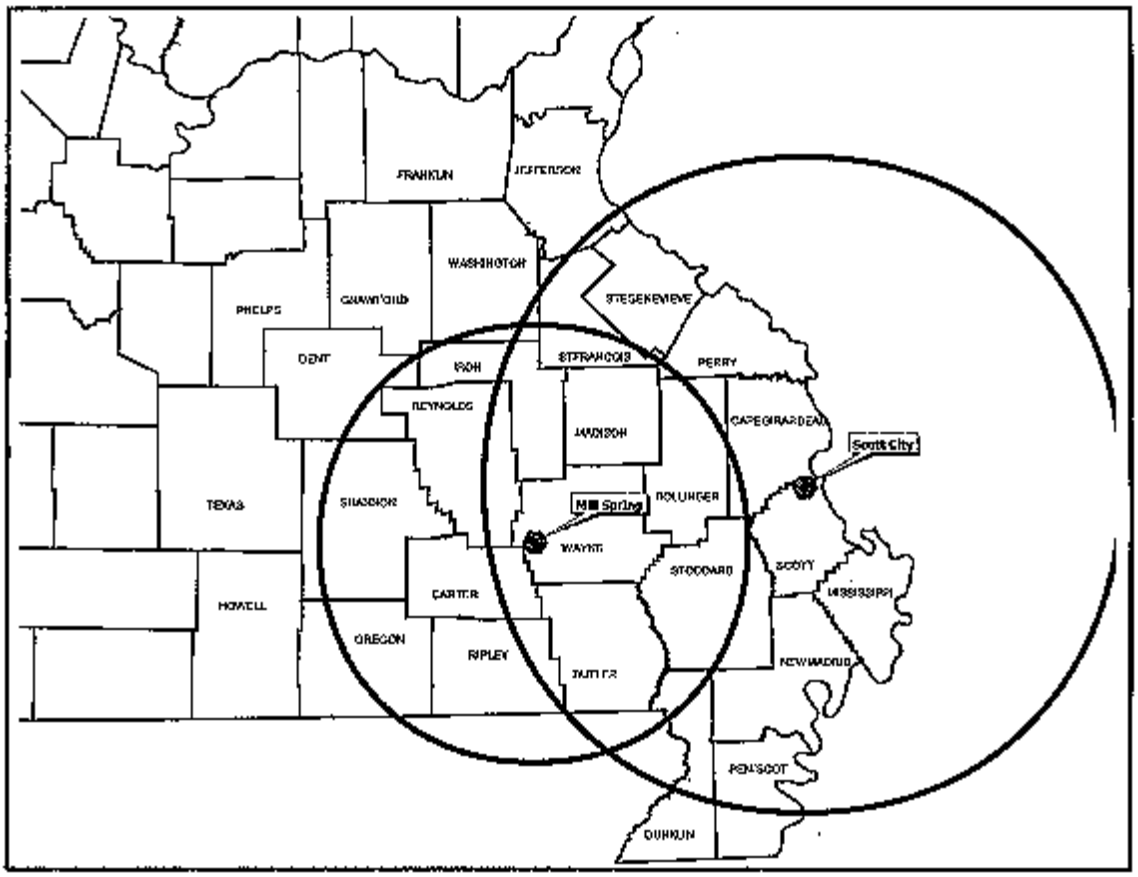

Table 2 Hardwood Availability in the 18 County Sourcing Area

	Million Acres	*Million Cubic Feet (mmcf)*								*Thousand Tons*
County	Timberland	GS (CI)*	Annual Growth (CI)*	% Growth	Drain '94	Balance	Harvest Residues '94	Rough Volume	Rough Annual Growth	Mill Residue
Bollinger	215.5	153.4 (+/- 11.0)	5.1(+/- 0.6)	3.3	3.0	2.1	2.2	52.6	1.3	16.9
Butler	130.7	92.1 (+/- 7.7)	2.3 (+/- 0.3)	2.5	1.1	1.2	0.8	31.9	0.6	7.2

Cape Girardeau	94.5	107.9 (+/- 11.8)	2.8 (+/- 0.6)	2.6	1.8	1.0	1.1	23.1	0.4	0.9
Carter	266.4	142.4 (+/- 9.2)	4.0 (+/- 0.3)	2.8	2.8	1.2	1.9	65.0	1.4	23.5
Dent	302.4	170.3 (+/- 11.0)	5.0 (+/- 0.5)	2.9	3.8	1.2	2.2	73.8	1.6	40.7
Dunklin	21.8	13.8 (+/- 2.8)	0.6 (+/- 0.2)	4.3	0.1	0.5	0.1	5.3	0.2	0.4
Iron	275.9	210.5 (+/- 12.5)	6.1 (+/- 0.6)	2.9	2.9	3.2	2.0	67.3	1.5	18.4
Madison	139.6	158.9 (+/- 10.6)	4.6 (+/- 0.5)	2.9	2.5	2.1	1.8	34.1	0.7	29.9
Mississippi	13.7	19.2 (+/- 4.6)	0.4 (+/- 0.2)	2.1	0.6	-0.2	0.1	3.3	0.1	0.0
New Madrid	18.9	7.4 (+/- 1.9)	0.2 (+/- 0.1)	2.7	0.3	-0.1	0.2	4.6	0.1	7.4
Oregon	292.6	169.2 (+/- 11.1)	5.5 (+/- 0.5)	3.3	4.8	0.6	3.4	71.4	1.7	45.8
Pemiscot	11.3	18.0 (+/- 4.8)	0.2 (+/- 0.2)	1.1	0.0	0.2	0.0	2.8	0.0	0.0
Reynolds	425.5	291.1(+/- 14.1)	8.6 (+/- 0.7)	3.0	10.4	-1.8	6.9	103.8	2.3	72.8
Ripley	269.0	175.9 (+/- 10.9)	4.7 (+/- 0.5)	2.7	3.5	1.2	2.5	65.6	1.3	21.1
Scott	19.1	29.9 (+/- 6.1)	0.6 (+/- 0.3)	2.0	0.4	0.2	0.3	4.7	0.1	0.0
Shannon	466.5	291.7 (+/- 14.0)	9.2 (+/- 0.7)	3.2	7.4	1.8	4.9	113.8	2.7	54.8
Stoddard	47.8	40.9 (+/- 6.7)	0.8 (+/- 0.2)	2.0	0.7	0.1	0.4	11.7	0.2	8.6
Wayne	386.5	263.1(+/- 13.6)	7.1 (+/- 0.6)	2.7	4.3	2.8	3.0	94.3	1.9	24.7
Total	3397.7	2355.7	67.8	2.9	50.4	17.4	33.7	829.0	18.1	373.0

*CI = confidence interval

An explanation of Table 2 follows. Annual growth is the annual volume of growth, in million cubic feet (mmcf), that occurred on the growing stock (GS). There was 67.8 million cubic feet of annual growth. The fifth column, labeled % Growth, is simply the annual growth divided by the growing stock and multiplied by 100. The numbers in the column labeled Drain '94 came from the 1994 Timber Products Output Survey in which all forest product owners were asked the volume of actual wood fiber harvested that year. Roughly 50.4 million cubic feet of growing stock was harvested in 1994 in the 18 county area. The 50.4 mmcf of drain is 17.3 mmcf less than the 67.8 mmcf of annual growth. So, there are 17.3 mmcf of growing stock that could potentially be harvested without touching the growing stock. The eighth column, labeled Harvest Residue `94, is that volume of wood fiber unused and left in the woods following harvest operations (drain). Harvest residues are tree tops, branches (> 3 inch diameter), and cull logs (rotten, hollow, crooked). There are 33.7 mmcf of residue that, while not usable as primary lumber products, may be utilized by chip mills. Because it is not realistic to assume that all of the residues would be picked up, we make an assumption that 50% of the total harvest residue is potential wood fiber for chip mills. Rough Volume, in the ninth column, is not included in the hardwood growing stock. In general terms, rough timber are short bodied trees of low commercial value. Technically, if a tree does not have two contiguous 8 foot segments or one 12 foot segment in the main bole of the tree, it is put into the rough

category. This category was included in Table 2, because Missouri has a significant volume of rough trees that can potentially be utilized by chip mills. The tenth column, labeled Rough Annual Growth, is that volume added to rough timber category through normal growth. The rough annual growth was calculated using the conservative assumption that rough trees will grow at 75% of the rate that growing stock will. The total annual growth of rough trees was 18.1 mmcf. The last column, labeled Mill Residue, is that portion of the growing stock that is processed by sawmills but does not go into a solid wood product (lumber, ties, landscape timbers, posts) and is not sawdust or bark (slabs, edging and trimming). This category is included because it is a potential source of chips. The total mill residue from this data set was 373,000 tons. Since chip mill capacity is measured in tons, we converted measurement units from mmcf to tons (31 cubic feet per ton) and summarized the forest resources potentially available for utilization by chip mills in Table 1.

A 1994 survey indicated that approximately 709 million board feet of timber was cut during that year (Piva and Jones 1994). Therefore, approximately 282,000 acres (2500 board feet cut/acre) received some type of harvesting during 1994. An additional 9,000 acres per year (3 percent) would be required to support the new chip mills.

Public Attitudes Toward Forest Resources

The 1997 Conservation Monitor Survey (Gallup 1997) found that 55% of respondents approved of cutting trees in Missouri to make lumber, furniture and other wood products.

A 1996 survey entitled *Missouri Citizens's Attitudes Towards Forest Resources: Comparative and Present Perspectives* (Constance and Rikoon 1997) found:

* 65% agreed that "generally speaking, public forest land is wisely managed in Missouri".

* 84% agreed that portions of public forests should be set aside where vehicles and timber cutting is not allowed.

* 46% had a high level of trust in the professional judgement of the Missouri Department of Conservation to care for the State's natural resources.

* 88% agreed that "carefully cutting trees is actually good for a forest over the long term".

* 38% noticed activities in forests which concerned them.

* 44% agreed that "generally speaking, private forest land is wisely managed in Missouri".

* 39% agreed that forest management activities on private forest should be regulated by the state.

* The average size forest holding was 73 acres.

* 15% of forest land owners said they received help from a professional forester.

These survey data suggest that more people think that pubic land is being wisely managed than private land. While the majority does not believe private forest land is being wisely managed, the majority does not support state regulation of private forest land. The vast majority of forest land owners do not receive help from a professional forester. These insights point to a problem, a lack of willingness to address the problem from a regulatory perspective, and a lack of willingness by the private forest land owner to ask for or accept management assistance from a professional forester.

Current MDC Private Forest Assistance Efforts

Providing quality assistance to private forest land owners requires an understanding of the state's forest conditions. Forest Inventory and Analysis (FIA) is a continuing endeavor and is mandated by the Renewable

Forest and Rangeland Resources Planning Act of 1974. The objective of FIA is to periodically (every 10 years) inventory the nation's forest land to determine its extent, condition and volume of timber, growth and depletions. USDA Forest Service regional experiment stations are responsible for conducting these inventories and publishing summary reports for individual states. The last FIA for Missouri was completed in 1989. The Forest Service is converting from a periodic inventory to a continuous survey in the state. This new approach will evaluate a portion of the state's forest resource every year. Forestry Division is proposing MDC administration to pay for the cost (about $200,000 per year) to double the sampling intensity on two of the units (Ozark and River Border) where timber harvest occurs most frequently. MDC purchased double sampling for these units in 1989, therefore while the accuracy of the 1989 and the upcoming survey will be identical, the methodology used is just different.

The Department also studies ways to improve the productivity of Missouri's forests. The Missouri Ozark Forest Ecosystem Project was started in 1990 and is a long term research project to judge the effects of even-aged, uneven-aged, and no-harvest management on various parts of the forest ecosystem (Brookshire and Shifley 1997).

The Department offers two levels of forest management assistance, based upon the landowner's need and interest: advisory service and management service. Advisory service is available to all landowners and includes group training sessions, publications, film and video loan, office consultation, insect and disease identification and analysis, referrals to consultants, on-site visits under certain conditions, and help with evaluating and choosing land management options. Management service is available to landowners who agree to develop and implement a management plan for the immediate and long term stewardship of their property. Activities in the management plan may include: marking and selling forest products; guidance for conducting timber stand improvement work; advice on tree planting, pest identification and analysis; and guidance in wildlife habitat improvement, erosion control, outdoor recreation development, soil and watershed protection, and forest road location and construction. Approximately 50 forest management plans, averaging 120 acres each, are being produced by MDC staff in the 18 county area per year. Therefore, approximately 6,000 acres per year are being added to the management "base" within the 18 county sourcing area. Because the demand for management service is greater than MDC staff can accommodate, forest owners are often referred to self-employed consulting foresters. A consultant can provide a wide array of management assistance to private landowners, often times on short notice. MDC foresters commonly schedule visits one year in advance.

The Department currently administers the Forest Cropland Program under authority of the State Forestry Law (1946). The law is designed to increase production of forest crops in Missouri by encouraging better management and protection of privately-owned forest land. This encouragement is in the form of a tax reduction on lands devoted exclusively to growing trees. Timber tracts of twenty acres or larger that are valued not more than $400 per acre are eligible. After application has been made and accepted by the Conservation Commission, the land is assessed at $3 per acre for the next 25 years. In return, the landowner must:

1. Have ownership boundary lines marked.
2. Prevent or extinguish wildfires.
3. Agree to not use the land for grazing of domestic livestock, erection of permanent buildings, impoundment of water, or installation of permanent wildlife food plots in excess of 3% of each 40 acres.
4. Manage the forest crop land according to a management agreement, with five year accomplishments.
5. When ownership of classified land is transferred, the new owner may assume the management agreement, or enter into a new agreement.
6. Cutting must conform to practices outlined in the management agreement.
7. Give written notice to the Commission thirty days prior to any cutting of timber.
8. Within one month following a commercial cutting or at the end of each month where the cutting is continuous, the owner shall file with the Commission a sworn statement showing the quantity of timber cut and the stumpage price received.
9. Pay a 6% "yield tax" on any timber harvest.

There are approximately 240 participants in the Forest Cropland Program in the 18 county area. The number of

program participants has steadily declined in recent years. Since inception of the Forest Cropland Program, wildfire issues have decreased (so priority fire protection is not a perceived benefit), timber values have increased (making the yield tax more expensive than the property tax), owner income has increased and property taxes have remained low (so the benefits of the tax relief are no longer attractive) and land value has increased (making most land ineligible). For these reasons we recommend amending the State Forestry Law to replace the Forest Cropland Program with a more attractive and effective incentive package.

The Department contributes $75,000 per year to the Missouri Forest Products Association (MFPA) Professional Timber Harvester Program. This training program is offered approximately six times per year and is attended by 10-15 loggers, foresters, forest contractors and landowners per session at a nominal cost ($135 per person). The MFPA Professional Timber Harvester Program lasts five days, and is broken down into an overview of forest management on the first day, followed by levels I - IV which address safety and techniques to increase timber harvest volume and quality. The morning of the first day is spent on an introduction to best management practices and forest ecology. Attachment B is a copy of the program brochure which includes the course description and topics covered. We recommend an increase in the emphasis placed on the use of BMPs in the Professional Timber Harvester Program.

The Department produced an educational booklet, entitled *Missouri Watershed Protection Practice* (Missouri Department of Conservation 1997) (Attachment C). The purpose of the booklet is to inform people involved in forest land management about the importance of reducing non-point source water pollution resulting from silvicultural activities and to describe some techniques used to reduce the impact on water resources. Because sediment is the non-point source pollutant traced to silvicultural activities, many of the recommended practices target reducing sediment production.

The Department sponsors a Master Woodland Steward Program for private landowners and other interested citizens. This program is centered around an 8 week short course (Saturdays and evenings) designed to educate participants on general forestry practices. Educating participants in tree identification, harvesting practices, forest ecology and pest identification are just a few of the topics covered during the course. The Master Woodland Steward Program began in 1998 and one class of approximately 25 participants has completed the course at this time.

The Department also assists the University Extension in southeast Missouri in the Master Tree Farmer Training Program. This program is very similar to Master Woodland Steward Program but occurs only in southeast Missouri. Several hundred participants have completed this program to date.

Forestkeepers is an MDC program that focuses on training interested groups and individuals in identifying pest and disease problems on their property. Participants also receive training in basic forest ecology principles. Over 1,000 volunteers are involved in the Forestkeepers program. Attachment D is a brochure about the program.

The Effectiveness of Best Management Practices

Best management practices (BMPs) are treatments applied during or following a harvest to stabilize the site and reduce the potential for non-point source pollution to occur. *Missouri Watershed Protection Practice* (Missouri Department of Conservation 1997) identifies topics (streamside zones, stream crossings, access roads and their construction, timber harvesting, site preparation, reforestation, and prescribed burning) and provides specific recommended practices as well as practices to avoid. Below are the results of a literature review which includes the use of BMPs as well as a comparison of some harvest methods.

Settergren et al. (1980) has conducted one of the only studies in the southeast Missouri Ozarks comparing sediment yield from a typical Ozark clearcut and selection cut with no harvesting (used as the control). No significant differences in sediment yield were found between harvest practices and the control. Flumes were

constructed at the base of each watershed and periodically monitored for a number of years following harvest.

McMinn (1984), conducting research in Georgia, contrasts ground skidding and cable yarding systems. Cable yarding results in 99 percent undisturbed soil and 1 percent soil exposed as compared to 63 percent undisturbed soil and 12 percent soil exposed for ground skidding. Cable yarding is used only on slopes in excess of 30 to 45 percent while whole tree clearcutting is utilized on lesser slopes but disturbs up to 98 percent of the site and exposes up to 18 percent mineral soil. Cable yarding, ground skidding and skidding for whole tree cuts return to preharvest conditions within three to six years. Sidle (1980) in North Carolina indicated that preplanning roads could result in a three fold decrease in soil compaction on the logging area. Locating the haul roads and constructing/repairing them to minimize soil disturbance requires locating roads on gentle slopes and minimizing their length, which ultimately reduces the cost of construction.

Lynch (1985) reports maximum stream water temperature increases from 3.3°ree; C to 10.5°ree; C following clearcutting. The minimum increase was associated with leaving a 100 foot buffer strip along perennial streams. Brown (1970), conducting research in Oregon, reported a 14°ree; F increase in stream water temperature associated with a clearcut with no buffer as compared to no increase in water temperature near a clearcut with a 50 to 100 foot wide buffer. Moring (1975), conducting research on the Alsea and Deer Creek Watersheds in Oregon, indicated that a 175 acre clearcut resulted in temperature increase from 61°ree; F to 85°ree; F, increased sediment deposit in streams from road construction and a decrease in population of trout from 265 to 65 in 0.5 stream miles. A 750 acre harvest in the Deer Creek watershed, where streamside vegetation was retained, resulted in minor temperature and sediment changes in an adjacent stream.

King (1984), in Idaho, reports that on unsurfaced, untreated, cut and fill slopes on a 207 acre watershed with 3.9 percent of the area in roads, the annual sediment increase is 156 percent. On a 161 acre watershed, having 2.6 miles of untreated, unsurfaced cut slope and dry seeded roadbeds, there was a 130 percent increase in sediment. On a 364 acre watershed, having 3.7 miles of surfaced roads, cut and fill slopes straw mulched and seeded, there was a 93 percent increase in sediment. On a 213 acre watershed, having 4.3 miles of surfaced roads, filter windrowed, cut and fill slopes hydro mulched and seeded, there was a 19 percent increase.

Kochenderfer (1984) reports that the use of one to three inch gravel can reduce road erosion by 50 percent compared to ungraveled surfaces. Swift (1984) indicates a 97 to 99 percent decrease in road erosion when new roads are covered with grass. Swift (1986) reports grassed cut and fill slopes, forest floor litter, and brush barriers to be effective in reducing movement of sediment away from roads.

Kochenderfer (1970), Rothwell (1978), Oregon Dept of Forestry (1981), and Ontario Ministry of Natural Resources (1988) indicate maintenance is essential in preventing future road erosion and sediment from abandoned roads. Additionally, road maintenance on usable roads is necessary to prevent erosion and provide a safe, operable surface for vehicular use by residents, school buses, etc.

Megahan (1980) reported on research conducted in the western United States and Canada concerning the percentage of logged area bared by roads, landings and skid trails for tractor skidding and other harvest methods. A British Columbia clearcut exposed 30 percent of the soil. An Idaho group selection had 9 percent bared soil. A California selection cut had 8 percent exposed soil. In Madison County, Missouri, three clearcuts, two pulpwood cuts and one conventional sawlog harvest are estimated to have 33 percent, 22 percent and 12 percent exposed soil, respectively (MDC internal investigation). Whole tree clearcutting in New England ranged from 18, 11 and 8 percent exposed mineral soil (Pierce et al. 1993).

Dissmeyer (1980) provides data on annual erosion rates for the Ouachita Mountains in Arkansas and other Eastern and Southern states. Site preparation including logging, prescribed fire, chopping, sheering, discing, dozing and grazing were analyzed. The recovery period from these site preparation techniques varied from two to four years. Soil loss ranges from 0.23 tons/acre/year (t/a/yr) to 3.6 t/a/yr for shearing, approximately 2.3 t/a/yr for logging, 0.6 t/a/yr for chopping, 0.8 t/a/yr for grazing, 0.89 to 1.9 t/a/yr for dozing, and 4.1 to 9.8 t/a/yr for disking. Mowing old fields is frequently conducted in Missouri. With continuous grass cover there is negligible erosion.

Beasley (1986) reported mean annual sediment loss for clearcutting followed by mechanical treatment and clearcutting with herbicides in Arkansas. Following treatments, the clearcutting-mechanical treatment yielded 421 lbs/acre over the preharvest level while the clearcut-herbicide was 185 lbs/acre over preharvest. Two years after the treatment the clearcut-mechanical treatment was yielding 1219 lbs/acre above the pretreatment level and the clearcut-herbicide treatment was 41 lbs/acre yield above the pretreatment level.

Golden (1985), conducting research in Arkansas, reports average erosion rates for dozing ranging from 0.89 t/ac/yr to 13.7 t/ac/yr depending on slopes and soils. K-G blade use ranges from 0.65 t/ac/yr to 4 t/ac/yr, chopping ranges from 0.22 to 0.24 t/ac/yr, disking ranges from 0.66 t/ac/yr to 4.1 t/ac/yr and chop and burn ranges from 0.38 t/ac/yr to 0.41 t/ac/yr.

Waters (1995) conducted a comprehensive review of literature related to the impacts of forestry practices on fisheries resources. He summarized the relationships between land use and fishery health. Sediment generation from various forestry practices including clearcutting, skidding, yarding, site preparation for replanting, and road construction and maintenance has been the focus of these studies. The relative contribution of sediment appears to be moderate from clear-cutting (i.e., higher than from selective cutting or patch-cutting), moderately high from skid trails, minimal from yarding (higher if heavy machinery is used near streams), and moderate from site-preparation. By far, excess sediment generation was greatest from logging roads, particularly if built near streams, and much greater if road construction created conditions for mass soil failures and landslides. Waters stressed that the logging road produced the most sediment generated among forest management practices.

Nutrient loss was described by Blackburn (1982) in Texas for a seven month period. Nitrates for sheared and windrowed ranged from 0.001 for the control to 0.227 kg/ha. Ammonium was 0.007 kg/ha for the control and 0.114 kg/ha for sheared and windrowed. Total nitrogen lost was 0.115 kg/ha from the control and 2.145 kg/ha from the sheared and windrowed.

Surveys indicate that 12% to 16% of the timber harvest activities in Missouri are done following a plan developed by a professional forester using BMPs. It is not known to what extent BMPs are being effectively applied on the remaining harvested areas. However, it is reasonable to assume that BMPs are not being effectively applied on a significant number of timber sales. Efforts to ensure their use on all sales needs to become a priority.

Numerous references are available that indicate not utilizing BMPs at a harvest site can significantly increase the amount of stormwater runoff, sediment transport off-site, nutrient leaching, and increase light penetration during the first few years following the harvest. These increases result in adverse impacts from 1) sedimentation, 2) nutrient enrichment, and 3) thermal warming in aquatic systems, which in turn, adversely impact water quality and reduce or eliminate fish, mussels, crayfish, and aquatic insects which are intolerant and/or sensitive to turbidity, low and fluctuating dissolved oxygen levels, and increased water temperatures.

Potential Timber Harvest Impacts

We did not find extensive literature specific to chip mills in Missouri. Most studies are based on forest ecosystems in the West, Southeast, East, Appalachian Mountains, or Coastal Plains and are not related to primary consumptive uses (e.g. chip mills versus saw mills). Topographic and climatic conditions in these areas are not consistent with Missouri. Idaho and other western forests are of a different species composition, subject to snow slides and switch back style road construction and susceptible to mass soil movement. The Coastal Plain region receive more rainfall than Missouri, while the Appalachians have steeper topography with longer slope lengths. We can only apply this information to Missouri resources using our best professional judgment to determine likely impacts. What follows is a literature review of results that we felt may be applicable in Missouri.

The following discussion provides some insight into the potential impacts of timber harvest on sedimentation,

soil compaction, biodiversity, aquatic species, socioeconomics, and groundwater. The literature review highlights the fact that the impacts are a function of the specific timber harvest technique being used, where on the landscape it is occurring, and what precautions are being taken to minimize negative impacts. One cannot separate out those harvest practices that are used to provide material to a chip mill versus a sawmill. In the 18 county area this report focuses on, the majority of harvest comes from private land. We know that the vast majority of private forest land owners do not consult a professional forester for timber management (about 85%). The following discussion is in general terms and assumes that BMPs are not used in the majority of timber harvests on private land.

Within the 18 county focus area, the *Missouri Clean Water Law, Water Quality Standards* designate the Current, Jack's Fork, and Eleven Point Rivers as *Outstanding National Resource Waters*, comprising a total of 246 miles. The majority of the mainstem portions of these rivers are contained within public ownership. Much of the tributary watersheds to these streams are in private lands. Within the 18 county focus area, there are five *Outstanding State Resource Waters* designated in the *Standards* [Big Creek (Wayne County); East Fork of Black River (Reynolds County); Little Black River (Ripley County); South Prong of Little Black River (Ripley County); Taum Sauk Creek (Reynolds/Iron Counties)]. The designated portions of these streams comprise a total of 18.8 miles. The designated segments are in public ownership but most of the surrounding, upstream watersheds are in private lands. Nine streams in the focus area are designated *Cold-Water Sport Fishing* streams, totaling 68.1 miles. Ownership is distributed through public and private ownership. Eighty-two streams within the focus area are designated *Cool-Water Sport Fishing* streams totaling 2,727 miles. Cool-Water Sport Fishing streams are those which have smallmouth bass/rock bass (goggleye) populations present in healthy numbers. Ownership is distributed through public and private ownership.

Harvesting without BMPs has been shown in the literature and in Missouri to result in increases in erosion, nutrient leaching, and waterbody temperature over the short-term (within the first five years) and, while none have been reported in Missouri, could cause violations of one or more of the *Standard's* regulations. Potential violations that can be expected in waterbodies ranging from small, Order #1 streams (direct impacts from the sourcing area) to larger, Orders #4 and #5 rivers (accumulative effects from several harvest areas). Violations of the *Standards* over the long-term are not likely, with or without a plan and BMPs, providing that the harvested area is returned to the former vegetative cover and land use.

Sedimentation

Nationwide less than five percent of the non-point source (NPS) impacts to water quality are from silvicultural operations (Society of American Foresters 1995). Of the silvicultural NPS, 90 percent is attributed to sediment deposition (Seehorn 1986, Society of American Foresters 1995, Scoles 1994).

Nearly ninety percent of the erosion from timber sales is traced to the road system (Patric 1980, Scoles 1994). Sediment movement is related to the amount of soil disturbance, percentage of area utilized by the logging roads, soil erosiveness, slope and slope length, amount of rainfall, and other factors (Scoles 1994, Seehorn 1986).

Sediment yield from bare soil occurring on bulldozed site preparation and roads is reported at high levels. This is similar to the amount of erosion from tilled crop land which is estimated at 17 tons per acre (Patric 1976, Seehorn 1986, Scoles 1994). Currently, bulldozing for site preparation is not utilized in Missouri. Bulldozing associated with land conversion is common in the Ozarks and has the potential to create substantial stream sedimentation.

Based on studies in the Ouachita Mountains of Oklahoma on established roads, sediment delivery to streams ranged from 3 tons per mile to 16 tons per mile, averaging 10 tons per mile of road annually (Scoles 1994). For most harvesting operations in Missouri, the special construction of logging roads is not required for access to forested tracts. In most cases, the main haul road from a timber sale is the county or state government-maintained gravel or hard surface road system.

Although the sediment delivery to streams from road building occurs at specific stream crossing sites, the

amount of sediment delivered has a significant impact on the short term health of a stream reach. Small streams produce invertebrate species which are food sources for fish. Eggs of some fish species will not hatch if covered by thin layers of sediment. Sight feeding fish, such as black bass and other sunfish, are sensitive to turbid water and suspended sediments which reduce visibility (Filipek 1993).

Roads and trails increase the exposure of soils to rainfall and increase surface runoff. Poor road and trail design and drainage often routes runoff directly to streams. Normal road and trail use and their maintenance expose fine sediments to rainfall and runoff. Once accelerated erosion starts, it is difficult to stop.

Soil Compaction

Soils are compacted to varying degrees through the use of heavy equipment. Soil moisture, texture, and freeze and thaw potential are natural conditions influencing the degree of compaction. Equipment weight and pressure through the tires or tracks concentrate or distribute equipment weight on the ground. The number of passes of the equipment and weight and type of load also influence the degree of compaction. Compaction limits water infiltration into the soil and can lead to accelerated erosion until the compacted soil once again allows water penetration.

Operation of the skidder requires repeated, concentrated travel over the some trails, resulting in exposed mineral soil. In proximity to the landing, skid trails are used more frequently than at locations situated toward the farthest part of the timber harvest area. As a result of repeated travels, compaction and exposed mineral soil is increased on and near the landing. Potentially serious compaction occurs when wheel ruts are deeper than about four inches and occur on approximately 4 percent of the area (Pierce 1993). After nine passes bulk densities increased at a depth of 7.5 cm (3 inches) for downhill skidding by 25 percent and uphill yarding by 45 percent. After 18 passes bulk density increased by 25 percent at a depth of 22.5 cm (9 inches). After three passes bulk density increased 10 percent throughout the top 30 cm (12 inches) of soil (Seehorn 1986). On soils which are well drained and excessively well drained, compaction is negligible (this describes most soils in the Missouri Ozarks). Fine textured soils tend to compact comparatively (Hesser 1975, Pierce 1993). Skidding of tree tops attached to the bole tends to support the bole of the tree, distribute its weight and prevent gouging of the soil as logs are removed to the landing (Hornbeck et al. 1986). On all sites, slight to moderate surface compaction is alleviated by frost and water action in a few years (Hesser 1975, Pierce 1993).

A study by Hornbeck et al. (1986) compared soil disturbance on three sites. In addition to the findings in Table 3, tye found ruts deeper than 10 cm occurred on 26 percent of the New Hampshire site. The Maine site had the deepest ruts with 3 percent of the area having ruts greater than 30 cm deep. Ruts can divert subsurface water flow, channel it and lead to accelerated erosion.

Table 3 Soil Disturbance on Three Sites (Hornbeck et al. 1986)

Location	Percent of Area Disturbed	Percent Disturbed but Covered by Organic Material	Percent with Completely Exposed Mineral Soil
Maine-- 116 acres	92	73	18
New Hampshire-- 16 acres	93	86	11
Connecticut-- 40 acres	84	71	8

Note: Percentages do not sum to 100 percent due to overlap in sampling.

Reducing the impacts from logging roads including the main skid trails, landings and haul roads, can be minimized by: 1) planning the logging road system to minimize the area disturbed, 2) using construction techniques that disturb less soil, such as using existing roads, locate roads to minimize soil disturbance, and avoid steep slopes, 3) using rehabilitation techniques, such as water bars on grades and vegetation to secure bare soil, 4) leaving a buffer strip between the road and stream, 5) crossing streams as little as possible, and 6) conducting logging uphill so logs are skidded away from streams where land ownership permits and roads are available.

Actions to reduce impacts from site preparation include: 1) wind rowing debris on contours, 2) leaving approximately 50 percent of the logging debris scattered over the site, 3) seeding the desired tree species with a quick cover, such as lespedezia, and 4) leaving a buffer strip of vegetation between the site and stream.

Biodiversity

The MDC Heritage Data Base was searched for records of species and natural communities reported for the sourcing area. A total of 4,431 occurrence records comprising 530 species or natural communities were reported. Forty-nine percent (1,948) of occurrence records are on private land with the other 57% found on public land or other protected lands where forest management must consider impacts to Heritage-tracked species. There is no legal requirement for appraising the impact of forest management on special status species and communities on private land. Thus, the Heritage sites on private land would be the most at risk of all of the sites in the sourcing area.

The private land natural communities in the Heritage Data Base could be altered through forest harvest. There are 269 natural community records on private land (38% of all community records), but only 36 are privately owned forest communities that could likely be logged, with the remaining as wetland and open land communities. Fifteen natural communities are bottomland forest and swamp communities in the Bootheel counties. The remaining are mesic to dry mesic upland forest community records in the sourcing area. These private land Heritage communities could be altered through logging even without the existence of chip mills.

Individual Heritage records in the sourcing area include recorded occurrences of 476 watch list, 124 status undetermined, 482 state endangered and 673 state rare elements. The state rare records comprised 149 species and the state endangered records accounted for 180 species. A total of 199 plant species classified as state rare or endangered occur in the sourcing area, with 31 of these plants records only from private land. Most of these plant species are found in habitats that will likely not be logged, including cliffs, glades, fens and sinkhole ponds. Some of these habitats, such as fens and swamps, can be degraded through erosion and water quality changes from adjacent timber harvest areas. There are 14 federally threatened or endangered species occurring in the sourcing area recorded at 248 locations. There are 28 wildlife, fish and insect species within the sourcing area recorded only from private land with 23 of these classified as state rare or state endangered.

A total of 250 Heritage elements are found (47% of all elements) only in the Natural Sections within the sourcing area. Four federal endangered species, pondberry, running buffalo clover, least tern, and cylindrical papershell, also only occur within the sourcing area Natural Sections and are not found in other portions of the state. Twenty-seven natural communities are recorded only from the sourcing area, but only three of these, wet prairie, dry-sand prairie and sand savanna, are only recorded on private land. The other natural communities are located on public land as well as private land. A total of 117 (47%) of the Heritage elements found only in the sourcing area are associated with aquatic natural communities such as marshes, fens, stream, caves, bottomland forest, etc. These species and natural communities depend on good water quality.

The Heritage data base contains 87 occurrence records for gray and Indiana bats with 40 of these occurring in caves on private land. The U. S. Fish and Wildlife Service established a five mile radius "may affect" zone around known hibernation caves. This zone is recommended to protect bats during the swarming period when large numbers of bats fly in and out of the cave to feed and mate (LaVal and LaVal 1980). Bats roost in nearby trees during the swarming period. Foraging can occur as far as 1.8 to 4.2 miles from the cave (Kiser and Elliot 1996). This "may-affect" zone is not a "no tree harvest" zone, but an area where the potential impact to endangered bats needs to be evaluated carefully.

The Missouri Ozarks is recognized as an important production area for forest Neotropical migratory birds (Fitzgerald 1997). Many species of high priority forest birds have centers of abundance in this region. For example, Breeding Bird Survey data indicate that this physiographic area supports 25% of the world's breeding Whip-poor-wills, 17% of Kentucky Warblers, 15% of Summer Tanagers, 14% of Worm-eating Warblers, 13% of Chuck-wills-widows, and 9% of Yellow-billed Cuckoos and Eastern Wood-Pewees. These bird populations appear to be breeding at or above replacement level and may be sources of individuals that colonize other

geographic areas where reproductive rates of forest birds are below replacement level due to forest fragmentation.

The Ozarks is important habitat for area sensitive bird species. The impacts of clearcutting on forest interior birds is short-term, provided that timber harvest is not followed by conversion to open land uses that would fragment the forest. Areas managed by clearcutting had higher densities of species dependent on early successional habitats and an increase in predatory birds and nest parasitism (Thompson 1993). But, Thompson and Dessecker (1997) found no loss of forest-interior or area sensitive species within sites managed by clearcutting. As succession progresses from regeneration to mature, bird densities are often lowest in mid-successional sapling and pole-sized stands.

Of the 128 migratory land birds that breed in the 18 county sourcing area, about 70 depend on forest communities. The Breeding Bird Survey indicates that about half of these birds are increasing and half are decreasing in abundance. Species of high management concern are those that depend on mature forest or on large-scale disturbances to create early successional forest habitat. The Partners In Flight Bird Conservation Plan (Fitzgerald 1997) identified 27 priority birds for the Ozarks that represent suites of bird species with similar habitat requirements. These suites of birds breed within a wide range of forested and semi-forested habitats. Diversity, through management, in forest size and ages classes, overstory canopy coverage and understory canopy coverage are needed to provide for all species.

The two harvest/management strategies most commonly used with chip mills are even-aged and uneven-aged management. While neither strategy fragments forest in the sense of producing isolated tracts, both create some degree of "edge" habitat within the forested landscape. Edge habitats typically attract both higher densities and a greater diversity of nesting bird species than are found in forest interiors, but also have been associated with increased levels of nest predation and parasitism. However, much of the research on edge effects has been done in fragmented landscapes or where forest abruptly meets agricultural fields. The few studies of edge effects resulting from both even and uneven-aged timber management in largely forested landscapes in the Midwest have produced variable results (Thompson et al. 1996). Ideally, there is a need for a mix of even-aged and uneven-aged silvicultural practices coupled with reserve areas. Landscape based habitat models indicated that almost any mix of sustainable forest management practices will likely sustain most bird species at the landscape level. Variation of patch size created by a mix of silvicultural methods will more closely mimic historic disturbance patterns. One silvicultural method uniformly applied across the region will have more impact by favoring one suite or birds over another than a variety of regeneration methods.

Large tracts of contiguous forest are important for many of the interior forest bird species. The Lower Ozarks contain the largest blocks of continuous forests in the state (Missouri Department of Conservation 1997). There are 102 tracts greater than 2,000 acres in size with several over 100,000 acres in this nine county region. Most of this land is privately owned but the core of the largest forested tracts are in Federal and State ownership.

The priority game species in the sourcing area are white-tailed deer, Eastern wild turkey, ruffed grouse and gray squirrel. Habitat requirements and food needs of these species are well documented for the Ozarks. Hard mast and acorns are an important resource for game species in oak-dominated ecosystems and acorns are one of the most important fall and winter foods of ruffed grouse (Korschgen 1966). Acorn production varies among trees but in general large diameter trees produce more acorns than smaller diameter trees (Johnson 1994). For squirrels, hickory nuts comprised 39.9% yearly diet (volume), acorns 16.1%, mulberry fruit 7.2%, and fungi 3.2% Korschgen (1977). Deer and turkey utilize hard mast for food during the winter. The eastern wild turkey diet is approximately 90% plant and 10% animal with acorns the most important staple food (Korschgen 1967). A mixture of black oak and white oak mast producing species will reduce the likelihood that mast failures will result in a complete lack of acorns (Missouri Department of Conservation 1986).

Deer and turkey feed in regeneration cuts, forest openings, and shrub-grass habitats where herbaceous and woody vegetation are often more dense and diverse (Korschgen et al. 1976). White-tailed deer will utilize regeneration cuts for feeding until trees reach 10 to 15 years of age when understory plant species numbers and abundance declines (Korschgen 1962). Turkeys will use regeneration cuts for brood rearing habitat up to the

pole size class.

Ruffed grouse have small home ranges and unlike most Neotropical songbirds, grouse use several habitats during the day (Kurzejeski et al. 1987). Thus, all of their habitat needs must be adjacent to the 10 acres of dense protective cover needed by adults. Regeneration stands of 10 to 40 acres are better for grouse because a mix of age-classes provides the variety of foods used by these birds. Regeneration cuts 5 to 10 years of age are preferred brood rearing and drumming habitat for ruffed grouse.

Each pair of squirrels needs a minimum of two dens. Forest land management guidelines contain recommendations for retaining potential cavity trees during timber harvest for cavity nesting wildlife (Missouri Department of Conservation 1986). In addition, squirrels are minimally affected by clear-cutting if cuts are smaller that ten acres and less than 500 feet wide to accommodate movement of squirrels to suitable habitat.

Maintaining forest corridors along streams and between open areas facilitates deer and turkey movements. Both deer and wild turkey make use of landscapes containing open areas with grasses and forest, areas with high browse production and sites with trees that produce acorns. Accordingly, regulating timber harvest activities to maintain a balanced age-class distribution with a 80-year rotation will provide a relatively consistent amount of forest habitat for forest wildlife with about 15% of the forest in ruffed grouse brood or adult cover (Thompson and Dessecker 1997).

The Heritage Data base contains 230 records of special status species using caves in the sourcing area. These records comprise 13 species. Except for the bats, all of these species depend on good water quality in the cave. Underground water quality is related to watershed management and land use in the cave recharge areas. The gray and Indiana bat feed on moths and mosquitoes in the canopy of upland and bottomland vegetation. Forest riparian corridors are important feeding areas for bats (LaVal and LaVal 1980).

Old growth forest in the sourcing area provides habitat for 270 wildlife species, with 87 depending heavily on this type of forest structure. Approximately, 100 to 250 years are required to produce old growth forest in Missouri under natural conditions. The age at which a forest becomes old growth depends on the longevity of the dominate overstory species. Old growth characteristics important to wildlife are large diameter trees, standing snags, dens and cavity trees, multi-layered vegetation structure, dead and down material, herbaceous canopy and tall canopy. Old growth forest management recommendations are available to integrate the conservation of this important habitat with other forest management activities (Meyer 1986).

Snag and cavity trees provide important habitat for at least 89 species of Missouri wildlife. In addition, 66 wildlife species use the dead and downed materials that result when snags fall. While old growth makes an important contribution to snag and cavity tree habitat, adequate numbers of cavity and snag trees must be provided in other overstory size classes. Distribution of snag and cavity trees is important to the distribution of wildlife. Cavity and snag tree management guidelines integrate this habitat component into other forest management practices (Titus 1985).

Woodland salamanders require a moist forest floor with protection from drying by the overstory canopy (Johnson 1987). Some lungless salamanders are found in logs and rocks on moist hillsides, while others depend on the vegetation along stream and creeks. Several species of mole salamanders occur in the sourcing area and most require downed logs and rocks in moist woodlands. Petranka et al. (1992) reported that woodland salamanders were eliminated from Appalachian clearcuts because of the change in microclimate and 50 to 70 years were needed for species to return to pre-disturbance levels. Hellbenders live under flat rocks in streams and rivers with clear water. This species cannot survive in turbid water and is an indicator of good water quality. The mole salamander (*Ambystoma talpoideum*) is the only woodland salamander found only in the sourcing area.

In conclusion, impacts to biodiversity from timber harvest could result from four major actions: 1) harvest at a rate faster than the annual growth, 2) forest harvest dominated by a single silvicultural method, 3) conversion of forest cover to other land uses following timber harvest, and 4) water quality degradation when BMPs are not

followed during harvest. These impacts can be mitigated with stewardship plans, technical assistance and the use of BMPs.

Aquatic Species

The rivers, streams, and lakes in the 18 county focus area support 187 species of fish, 58 species of mussels, 24 species of crayfish, and 574 species of aquatic invertebrates. Within these counties, there are 55 species of aquatic wildlife that are considered to be federal or state Rare and/or Endangered or have their Status as Undetermined or Watch List based on their limited abundance and/or distribution within its known range. Of these, there are 36 species of fish (19% of all species present), 8 species of mussels (14%), 7 species of crayfish (29%), and 4 species of aquatic invertebrates (<1%). Several of the crayfish and invertebrates are endemic to this region. Eleven of these listed species (20% of the total listed species) are found only on private land. These include five fish species (14% of the listed fish), threemussel species (38% of the listed mussels), one crayfish species (14% of the listed crayfish), and two aquatic invertebrates (50% of the listed invertebrates). All of the species in these categories are intolerant of abrupt changes in their habitat and environment. Many are intolerant of turbid conditions caused by erosion and sedimentation, low dissolved oxygen concentrations resulting from the effects of nutrient leaching and enrichment, and warmer or fluctuating water temperatures resulting from insufficient or the removal of riparian canopy.

Wood fiber harvesting activities conducted using BMPs should not cause violations of the *Missouri Clean Water Law,* which in-turn should not cause lasting impacts in isolated areas or the total assemblage of aquatic life in the region, including the listed species.

Harvesting without BMPs has a significant likelihood of causing *Missouri Clean Water Law* violations via increased erosion, nutrient leaching, and elevation of waterbody temperature over the short-term and in-turn will cause species composition changes or elimination of intolerant, and even facultative, aquatic life. Impacts from sedimentation will be the most noticeable, resulting in reduction and/or elimination of intolerant species and their habitat.

These impacts are not likely to be extended over the long-term or be permanent if the harvested area(s) is not altered drastically and is returned to the former vegetative cover and land use. If the alteration is severe enough or vegetative cover and land use is changed, species extirpation can result.

Water quality and aquatic species composition in waterbodies on public lands should not be adversely impacted or changed. Since 85% to 90% of the timber fiber harvest in the sourcing area will likely be done on private lands and without the assistance or advise of a professional Forester or use of BMPs, concerns for both water quality and the welfare of aquatic communities in and downstream of the harvest sites are valid and short-term degradation and losses are likely.

A recent review of literature related to the impacts of forestry practices on fisheries resources (Waters 1995) summaries the relationships between land use and fishery health. Waters stated that the concern about the influence of sediment and other effects on stream fishes is the greatest in forested regions with immense standing timber resources and cold water fisheries, mainly in the Northwest and Southern Appalachians. Investigations into forest management problems documented severe losses in fish populations and fish harvests, and reduction in underlying basic productivity. While areas in the Southern Appalachians most near resemble the Missouri Ozarks, Waters mentions that very little information exists on specific effects of sediment on warmwater fishes in wooded regions. He feels that the lack of research attention into specific impacts of forest-management practices on warm-water fisheries is the primary reason that few forest-practice sources of excess sediment have been identified as affecting warmwater streams and their inhabitants. It is felt, however, where poor forest management practices are conducted in steep topography or near streams, the impacts to the aquatic resource is similar to those documented throughout the literature.

In Missouri, there are 3,837 miles of streams within the 18 county focus area that are classified as permanent and/or intermittent in the Missouri Clean Water Law, Water Quality Standards (1996) and therefore protected against impacts which are chronic or acute in nature. Nearly one-fourth of these classified waters (23.8%) are

protected as cold and cool-water habitat. Elevation of water temperatures by a pollutant or land use practice is a major concern. Many of the inhabitants of these waters are also intolerant of turbidity and sedimentation. The impacts of poor forest management practices, discussed by Waters and the literature that he reviewed, can be directly applicable to these 900+ miles of Missouri Ozark streams and their inhabitants. The principles in general can apply to the remaining warm-water segments of classified streams in this area as well as the greater mileage of unclassified streams that are present. Where forest management is done correctly, these concerns are minimal or non-existent.

Socioeconomic

The macroeconomic impacts from any investment can be divided into two categories, direct and indirect. All figures below are per year. Direct effects include employment and payroll at the mill(s), stumpage paid to the landowner, etc.

A new 600,000 ton chip mill in Tennessee (with 17 employees and 182 harvest-related jobs) was estimated to have $7.7 million in direct effects, including stumpage. Because of the benefits (to the landowner) of increased competition, three new mills with 1.9 million tons of capacity were estimated to add 636 jobs and $29.7 million in direct effects in the same area (Tennessee Valley Authority 1993). These estimates were made with stumpage prices varying from $40 to $130 per acre.

An Arkansas study of three new chip mills, with a combined capacity of 1.1 million tons showed 370 new jobs and $6.7 million in direct benefits. This estimate was made using a stumpage figure of about $4.50/ton (Gray and Guldin 1997). A single 300,000 ton mill in Missouri would then be expected to yield between 70 and 120 indirect jobs, and between $1.4 million and $6.5 million in total indirect benefits. The total economic impact of one 300,000 ton new chip mill in Missouri is estimated to be between 160 and 220 jobs and $3.2 million and $11.1 million.

Impact on Existing Forest Industry.

There is a multitude of evidence for either a growing demand for wood fiber products (West 1992, Nonemacher 1989) or stable demand and reduced supply (Sedjo 1994, Hetemaki 1992). According to microeconomic theory (e.g. Varian 1984), this should lead to an influx of new industry and/or higher product pricing, both of which have been observed (Jones 1998, Wood Technology 1998, Tennessee Valley Authority 1993, Adams 1992). Despite these trends, Gray and Guldin (1997) find that the small sawmill industry (in Arkansas) is volatile and is expected to remain so. No relation was found to the presence or absence of new mills. The Tennessee Valley Authority (TVA) (1993) equally found that there would be no "serious impact" to existing industry. Missouri's own existing industry is, like Arkansas', small scale and volatile (Piva and Jones 1997) and there is no reason to expect that it will react differently than Arkansas' or Tennessee's. The impact on existing industry should be negligible.

Impact on the Tourism Industry.

Chip mills are often thought or accused of being associated with unsightly clearcutting. Clearcuts have been found in many studies to have a negative impact on aesthetics, recreation and tourism (Loomis 1996, Pope and Jones 1990, Walsh et al. 1984). Both the Arkansas and the Tennessee studies find that potential impacts on the tourism industry "would be highly variable", depending on the size, location, and type of the harvest (Gray and Guldin 1997, Tennessee Valley Authority 1993).

Gray and Guldin (1997) link the loss in tourist dollars (direct and indirect) to the number or acres clearcut (the assumed method of harvesting), the recovery period of the forest, and to the size of the existing tourism industry. At a harvest of 5,300 acres/year (approximately 220,000 tons), the impact is estimated at 7.6 of 11,248 total jobs and $0.11 million of $161 million total dollars. For a harvest of 29,200 acres/year (approximately 1.1 million tons), the impacts become 41.7 of 11,248 total jobs and $0.6 million of $161 million total dollars. These figures assume a 30-year recovery period. They are calculated on a simple ratio of acres harvested to total acres. All in all, the effects are minimal.

The TVA's analysis is equally simplistic, using a fixed percentage loss per acre. They find total losses of between

2 and 70 jobs and $0.5 million and $4 million total dollars. Again the effects are minimal compared with the total tourism industry.

Other studies have been undertaken to estimate the loss of recreation (tourism) benefits from other causes of temporary deforestation, for example insect pests (Leuschner et al. 1996) or the benefits due to increased forest preservation (Pope and Jones 1990, Walsh et al. 1984). Some of the studies have found much higher total losses than Gray and Guldin or TVA. Walsh et al. for example, put the present value of all future costs and benefits (remember that other values have been stated on a per year basis) of forest recreation at between $220 and $1,246/acre. Such figures could put the Arkansas total loss at as high as $4.5 million per year or more, depending on the discount rate used and using current dollars. Such studies, however, were not specifically designed to look at chip mill harvesting on private lands and may not be applicable.

In general, Missouri can expect an insignificant effect on the direct portion of its tourism industry. Impacts on the indirect and non-market values associated with a forest that is perceived to be aesthetically pleasing, well-managed and preserved are harder to assess (the studies mentioned above are somewhat hypothetical).

Impact on Forest Landowners.
One possible benefit of new chip mills is the market they may provide for non-industrial private forest (NIPF) landowners to sell a product that was previously unsaleable. Gray and Guldin (1997) identify four conditions of the "ideal" market for hardwood pulpwood. An ideal market would 1) take rough and rotten trees, poor form trees, etc, 2) take otherwise unsaleable species, 3) take thinnings and tops from hardwood sales, and 4) take thinnings and tops from hardwood stands not yet ready for hardwood harvest.

They find that chip mills in Arkansas satisfy only conditions 1) and 3), with 3) being insignificant in volume. They conclude that the new market they provide to NIPF landowners is, in fact, quite small, or a "niche" market. However, the situation in Missouri may be different because Missouri has had a negligible chip market in the past compared to today. Arkansas has had a viable chip market for many years.

Nyland (1992), however, [and TVA (1993) in the case of more than one new mill] find that the mills may increase demand enough to raise stumpage prices to significantly benefit NIPF landowners. Nyland proposes that this increase may even be enough to allow landowners to invest in forest management that would improve forest quality, health and productivity.

A new mill with sourcing in Missouri will provide a market for its input, and may raise stumpage prices enough to benefit landowners. This scenario has already occurred in Missouri (Field Forester personal communication). But it is possible that many landowners will not be adequately informed to take full advantage of the new market (Constance and Rikoon 1997). Marcouiller et al. (1996) suggest that any accounting of new regional value added due to such new markets include a full social accounting of not only primary and secondary wood processing, but also sustainability and non-market values (see below).

There is some, justifiable concern that this new market for smaller sized wood will increase conversion from timberland (Hardie and Parks 1996, Arkansas Business 1996). Hardie and Parks find, however, that the level of conversion has more to do with other landowner alternatives and incentives (e.g. cost sharing reforestation programs), than with the chip mill market. Burke and Luloff (1994) caution that public policy decisions should not be made on the basis of the assumption that NIPF landowners have different values towards natural resources than the general public. Their survey work found that NIPF landowners were equally likely (or unlikely) to hold "utilitarian" attitudes towards forest management. They suggest that better public education and outreach is a more useful solution.

Impact on Property Value and Property Tax Base.
TVA (1993) found that the proposed new mills in Tennessee had no effect on timberland property values. All increased value was captured by stumpage price changes. The new mills pay property taxes at the prevailing rate, absent any special tax incentives. Missouri can expect the same effects.

Non-Market Values: Forests have value to individuals and to society apart and above from their value as a source of raw materials. Boyle and Bishop (1987) subdivide a resource's value to society. They argue that there are three "basic groupings". *Consumptive use* values involve actual, physical use of a natural resource amenity (e.g. harvesting a tree). These values have been discussed above. Contact, or *non-consumptive use* values arise when the user comes into contact with the natural resource amenity, but does not physically consume or change it (e.g. birdwatching in a forest). Boyle and Bishop group these first two subdivisions together as *direct use values*. *Indirect use* values arise when individuals gain satisfaction or utility without ever coming into direct contact with the natural resource amenity in question. Reading about a forest or seeing a photograph of a spectacular forest view would fall into this category. Mitchell and Carson (1989) use slightly different terminology for a similar division of value. Randall and Stoll (1983), Boyle and Bishop (1987) and others also write of *existence value*, defined as the value that may be generated by simply knowing that natural resource amenities, exists. Such values might be due to altruism of various types. Some individuals might want to leave "beautiful views" intact as a bequest to future generations; intergenerational altruism.

Non-market values of landowners will certainly play a role in their willingness to sell or not sell their timber. The new chip market would not likely change the views of landowners concerning the fate of their own forest land. However, those individuals with strong views toward scenic value of forests or maintaining old growth (as examples) would voice their opposition to a chip mill facility because of the threat of increased harvest. Because property rites in Missouri ensure the landowners ability to harvest (as long as they do not violate the Clean Water Act), individuals with concerns about chip mills would most likely focus on expressing their opinions to public agencies.

Cost/Benefit Analysis: The figures in this literature review are from too disparate a variety of sources to allow for a full, reliable cost/benefit analysis of the situation in Missouri. However, an approximate overview can be given.

Missouri could expect direct benefits of between $1.8 million and $4.6 million per year from a single 300,000 ton chip mill, and $1.4 million and $6.5 million in indirect benefits, for a total of between $3.2 million and $11.1 million per year. These numbers, if one accepts the methodology of the Tennessee and Arkansas studies, capture all the benefits to nonindustrial private forest landowners of the new market, as well as all other direct and indirect market benefits.

Based on the literature available from other states and taking some large assumptions regarding places, times, and situations, a chip market in Missouri could yield potential benefits of $3.2 million to $11.1 million, and costs from $1.5 million to $10.5 million. Recall that "costs" here should include all losses to society: recreation, bequest (forests for our children), future option, irreversible biological loss, and anything else the public may value, but not find a market for, in Missouri's forests. Given the uncertainties and methodological problems associated with the estimation of benefits and the hypothetical and inferred nature of the estimation of costs, the result is slightly positive, but probably statistically too close to call.

As is indicated in the text above there is a great deal of uncertainty regarding the costs and benefits of chip mills in Missouri. A study focused in Missouri to accurately assess the situation may be required if reliable numbers are needed.

Groundwater

Timber harvesting can result in impacts to groundwater elevations and geologic formations. Erosion and sedimentation can change drainage patterns and result in altered recharge rates to groundwater.

Erosion and sediment movement can result in changes to groundwater quantities and quality, especially if direct recharge occurs. Road construction can cause impacts to groundwater resources by changing the surface drainage courses, which in turn alters recharge to the subsurface drainage system. Additionally, roads can compact subsoils, creating zones of low permeability and decreasing the recharge area. As more and wider roads are built on increasingly steep topography, the potential for damaging effects of erosion and sedimentation increase accordingly (Sopper and Lull 1967).

Sediment loading to subsurface and surface streams will vary by location and by harvesting methods within the timber sourcing area. Caves and cavities function as giant traps, accumulating sediment, chemicals and organic debris. Sediment can cause plugging and choking of sinkholes and subsurface drainage that can result in localized flooding in addition to the impacts to caves and other features.

Changes in surface and subsurface drainage would also result in changes to localized groundwater levels; both lowering and raising of groundwater levels would occur. The plugging of solution channels can cause groundwater levels to increase upstream, while downstream water levels may decline because of increased surface drainage. Changes in water levels, especially lowering, can result in sinkhole subsidence and collapse. A potential also exists for altering groundwater flow rates to domestic wells, industrial wells, and springs used for water supplies.

Summary of the Field Trip to Tennessee

On August 13, 1998, Lynn Barnickol, Al Buchannan, Jane Epperson, Bruce Palmer, Russ Titus, David Urich and Tom Lange (DNR) flew to LaFollette, Tennessee to look at areas impacted by chip mill harvests and to discuss chip mill issues with industry, state foresters and environmental groups.

While in eastern Tennessee we met with Ted Daly and Bob Wright (Tennessee Division of Forestry), John Flynn and Ken Leach (Champion International Corporation), Dr. Lee Barclay (USFWS), Cielo Sand (Dogwood Alliance), Doug Murray (The Center), Marg & Marvin Ellis and Barbara Levi (Save Our Cumberland Mountains).

Tennessee is approximately 50 percent forested, while the Eastern region is approximately 70 percent forested. Wildfire and high-grading have played a significant part of the region's forest history. Forest land ownership in the Eastern region includes approximately 47 percent farmers and individuals, 36 percent private corporations, 2 percent forest industry, and 15 percent government. According to both the Tennessee Division of Forestry (TDF) and Champion foresters, coal mining had a significant impact on the forest. Typically, the coal companies high-graded the forest. Black locust, grasses and other plants were used to revegetate the mined areas. Overall forest growth rates are approximately 3 percent on growing stock, which is similar to that of Missouri.

Champion procures wood from suppliers within a 120 mile radius of the facility. Champion has one procurement manager and two procurement foresters who are responsible for a 12 county area. Procurement foresters visit the suppliers regularly. They encourage loggers to attend the Tennessee Master Logger Program which is operated by the forest industry and consists of: BMP training, forest ecology, silviculture, safety and business management topics. Champion shares the $100 cost of the class but the suppliers have to pay their employees wages during the five day long class. Beginning January 1, 1999, Champion will initiate a Preferred Supplier Program providing incentives for operators who are identified to be consistently following the Master Logger Program criteria. Incentives include three year contracts with log price adjustments and allowing the operator to extend time for periods of wet soil conditions.

Champion runs about 400,000 tons per year through its chip mill, three quarters or 300,000 tons of this as primary chips from pulpwood and one quarter or 100,000 tons as residual chip from sawmill operations. It takes 350,000 tons of pulpwood to get 300,000 tons of chips due to moisture loss, waste, etc. If all their supply came from clearcuts, it would take 7,000 acres per year of clear cut timber to supply 350,000 tons of pulpwood, less than 1% of the acreage available within a 120 mile radius of the mill. About half of the pulpwood supply comes from clearcuts and half from high-grade cuts.

TDF cooperates with the Tennessee Environmental Quality agency (TDEQ) in this way: Forestry technicians are directed to survey harvests and network with loggers. If they encounter a water quality problem, it is reported to a TDF water quality specialist who can make contact with the logger and land owner to work through the issue. Additionally, a citizen complaint can be reported to the TDEQ, who will secure permission for access and make

an evaluation. Permission to enter the private land is always secured in a friendly way. A warning letter can be issued from the forester, followed by a Notice of Violation from TDEQ, if necessary. The key seems to be developing a friendly relationship between TDF, the land owner and the logger. The approach has measurable components and serves as a basic monitoring step on the use of best management practices.

In the afternoon, we were taken to a site belonging to another company, Brimstone. The site was poorly designed, with one particularly bad haul road which was resulting in the siltation of a nearby stream, and two or more wet-weather drainages. The BMP violation involved diverting a stream and heavy sedimentation of an ephemeral stream. The road segment we observed was located on a grade estimated to be in excess of 25 percent, slope length was approximately 700 feet. An installed culvert did not pass the water runoff. Evaluation of the two road prisms and the ephemeral stream draining into the culvert should reveal that the culvert was too small. Water bars installed on the recently constructed road were compromised by runoff, seeding was attempted but did not germinate well. Additional road length was observed impacting a second drainage containing significant sedimentation. The harvest of trees was by clearcutting.

Later in the afternoon, we flew over the Cumberland Plateau to get a bird's eye view of the region. We saw areas being harvested or that had been harvested during the past few years, and there were some large acreages of conversion to pine plantation. Overall, the harvested areas were small compared to the huge acreage of forest out there.

We came away from the field trip with a number of realizations and questions:

> Champion International Corporation is a good citizen that takes a proactive role in encouraging the use of best management practices on the timber they procure, and support of the Master Logger Program. Their efforts are making a difference.

> Conversion to pine plantations, which is a concern in Tennessee, is not likely to be a big issue in Missouri. Pine conversion is a possibility in Missouri but, due to planting expense and limited markets for pine, it does not appear to be a future trend.

> Tennessee's forest land is owned by a higher percentage of corporations and forest industry than in Missouri. Thus, Missouri's smaller acreage and more private ownership makes it more difficult to impact/encourage sound forest stewardship.

> Missouri forest terrain is not as mountainous as Tennessee's. We usually log uphill, away from the drains. Many of our roads are on ridges.

References

Adams, D. 1992. Long-term timber supply prospects in the United States. Journal of Business Administration. vol. 20(1,2).

Beasley, R.S. and A.B. Granillo. 1985. Water yields and sediment losses from chemical and mechanical site preparation. In Forestry and Water Quality - A Mid-South Symposium, Arkansas Cooperative Extension Service. pp106-116.

Blackburn, W.H. 1982. Forest site preparation and water quality in Texas. Proceedings of the Specialty Conference on Environmentally Sound Water and Soil Management, ASCE, Orlando, Florida, July: 20-23, 1982, ed. E.G. Kruse, C.R. Burdick, and Y.A. Yousef. pp57-66.

Brookshire, Brian L. and S.R. Shifley. 1997. Proceedings of the Missouri Ozark Forest Ecosystem Project Symposium: an experimental approach to landscape research; 1997 June 3-5; St. Louis, MO. Gen. Tech. Rep. NC-193. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment

Station. 378 p.

Fitzgerald, J. 1997. Partners in flight bird conservation plan. Physiographic area 19: The Ozark/Quachitas. Missouri Dept. Conservation, Jefferson City, MO. 70pp.

Boyle, Kevin and Richard Bishop. 1987. Valuing wildlife in benefit-cost analyses: A case study involving endangered species. Water Resources Research, v.23, no.5pp. 943-950.

Brown, G. W., and J.T. Krygier. 1970. Effects of clearcutting on stream temperature. Water Resources Research, 6(4): 1133-1140.

Burke, Lisa and Luloff, A. 1994. Attitudes toward the management of nonindustrial private forest land. Society and Natural Resources. vol 7(5).

Constance, D. H., and S. Rickoon. 1997. Missouri citizen's attitudes towards forest resources: comparative and present perspectives.

Dissmeyer, G.E. 1980. Predicted erosion rates for forest management activities and conditions in the Southeast. In U.S. Forestry and Water Quality: What Course in the 80's? Proceedings, Richmond, VA, June 19-20, 1980. pp42-49. Water Pollution Control Federation.

Ellefson, P.V., A.S. Cheng and R.J. Moulton. 1995. Regulation of private forestry practices by state governments. University of Minnesota, Minnesota Agricultural Experiment Station Bulletin 605-1995.

Filipek, stephen P. 1993. The impact of forest practices on warmwater and coldwater fisheries: similarities and differences. Arkansas Game & Fish Commission, Fisheries Technical Report. No. FR-93-1.

Golden, M.S. 1984. Forestry activities and water quality in Alabama: effects, recommended practices, and an erosion-classified system. Auburn University Agricultural Experiment Station, Bulletin 555.

Gray, John and Guldin, James. 1997. Hardwood chip export mills in Arkansas--implications for sustainabilty. Proceedings of the 1997 Symposium on Arkansas Forests. Little Rock.

Hackett, R., Jones, S., and R.J. Piva. 1991. Missouri timber industry--an assessment of timber product output and use, 1991. USDA Forest Service, North Central Forest Experiment Station, Resource Bulletin NC-151, 45pp.

Hardie, Ian and Parks, Peter. 1996. Program enrollment and acreage response to reforestation cost-sharing programs. Land Economics. vol. 72(2).

Hesser, Robert, et. al. 1975. Clearcutting in Pennsylvania. School of Forest Resources College of Agriculture, Pennsylvania State Univ.

Hornbeck, J.W., C.W. Martin, and C.T. Smith. 1986. Protecting forest streams during whole-tree harvesting. N.J. Applied Forestry 3:97-100.

Johnson, T. R. 1987. The reptiles and amphibians of Missouri. Missouri Department of Conservation, Jefferson City, MO 368pp.

Jones, Shelby. 1998. Missouri timber price trends. Various issues. Missouri Department of Conservation.

King, J.G. 1984. Ongoing studies in Horse Creek on water quality and water yield. NCASI Technical Bulletin 435. pp28-35.

Kochendefer, J. N. 1970. Erosion control on logging roads in the Appalachians. USDA Forest Service, Northeastern Forest Experiment Station, Research Paper NE-158.

Kochenderfer, J.N. and J.D. Helvey. 1984. Soil losses from a "minimum-standard" truck road constructed in the Appalachians. In Mountain Logging Symposium Proceedings, June 5-7, ed. P.A. Peters and J. Luckok, West Virginia University.

Korschgen, L. J., W. R. Porath, & O. Torgerson. 1976. Spring and summer foods of deer in the Missouri Ozarks. Missouri Deptartment of Conservation. P-R Proj. W-13-R-30. Study XXVI, Job 1. 55p.

Korschgen, L. J. 1962. Foods of Missouri deer, with some management implications. J. Wildl. Manage. 26(2):164-172.

Kurzejeski, E. W., B. W. Hunyadi, and D.A. Hamilton. 1987. Ruffed grouse in Missouri: restoration and habitat management. Terr. Ser. 17. Missouri Department of Conservation, Jefferson City, Missouri. 13pp.

LaVal, R. K. and M. L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Terrestrial Series 8. Missouri Deptartment of Conservation, Jefferson City, Missouri. 52pp.

Leuschner, William, et al. Potential benefits of slowing the gypsy moth's spread. Southern Journal of Applied Forestry. Vol 20(20).

Loomis, John. 1996. Measuring general public preservation values for forest resources: evidence from contingent valuation surveys. Adamowicz, W.L., et al., (eds.) Forestry, Economics and the Environment., ed. CAB International, Oxford.

Lynch, J.A., E.S. Corbett, and K. Mussallem. 1985. Best management practices for controlling non-point source pollution on forested watersheds. Journal of Soil and Water Conservation, 41(1):164-167.

Marcouiller, David et al. 1996. The impact of forest land use on regional value added Review of Regional Studies. vol 26(2).

McMinn, J. W. 1984. Soil disturbance by fuelwood harvesting with a conventional ground system and a cable miniyarder in mountain hardwood stands. Mountain Logging Symposium Proceedings, ed. P.A. Peters and J. Luchok, June 5-7, 1984. West Virginia University. pp93-98.

Megahan, W.F. 1980. Nonpoint source pollution from forestry activities in the western United States: results of recent research and research needs. U.S. Forestry and Water Quality: What Course in the 80's?. Proceedings of the Water Pollution Control Federation Seminar, Richmond, VA, June 19, 1980. pp92-151.

Meyer, J. 1986. Management of old growth forests in Missouri. Habitat Management Series 3. Missouri Deptartment of Conservation, Jefferson City, Missouri. 16pp.

Missouri Code of Regulations. 1996. 10 CSR 20-7.031 Missouri Clean Water Law, Wather Quality Standards. pp10-136.

Missouri Department of Conservation. 1997. Missouri's conservation monitor 1994- 1997. Public Profile 2-97, Missouri Department of Conservation, Jefferson City, Missouri. 37pp.

Missouri Department of Conservation. 1997. Missouri watershed protection practice; 1997 management guidelines for maintaining forested watersheds to protect streams. 27pp.

Missouri Department of Conservation. 1997. Inventory notebook for the Ozark Region.
Missouri Department of Conservation, Jefferson City, Missouri.

Missouri Department of Conservation. 1986. Forest land management guidelines. Missouri Department of Conservation, Jefferson City, Missouri. 81pp.

Mitchell, Robert and Carson, Richard. 1989. Using surveys to value public goods: the contingent valuation method. Resource for the Future, Washington, D.C.

Moring, J. R. 1975. The Alsea Watershed study: effects of logging on the aquatic resources of three headwater streams of the Alsea River, Oregon, Part 1 - biological studies, fishery report number 9. Oregon Department of Fish and Wildlife, Corvallis, Oregon. 66pp.

Nonemacher, R. 1989. Impacts of forest industries on forest resources in the South. USDA Forest Service Pub. 1473.

Nyland, R. 1992. Exploitation and greed in Eastern hardwood forests. Journal of Forestry. Vol. 90(1).

Ontario Ministry of Natural Resources. 1988. Environmental guidelines for access roads and water crossings. Queen's Printer for Ontario, Ontario, Canada.

Oregon Department of Forestry. 1981. Road maintenance. Forest Practices Notes No. 4. Oregon Department of Forestry, Forest Practices Section, Salem, Oregon.

Patric, J.H. 1980. Effects of wood products harvest on forest soil and water relations. J. Environ. Qual., Vol. 9, no. 1. p. 73-80.

Patric, J.H. 1976. Soil erosion in the Eastern forest. J. For. 74:671-677. Petranka, J. W., M. E. Eldridge, and K. E. Haley. 1992. Effects of timber harvesting on southern Appalachian salamanders. Conservation Biology. 7(2):363-370.

Pierce, R.S., J.W. Hornbeck, C.W. Martin, L.M. Tritton, C.T. Smith, C.A. Federer, and H.W. Yawney. 1993. Whole-tree clearcutting in New England: manager's guide to impacts on soils, streams, and regeneration. USDA Forest Service, Northeastern Forest Experiment Station. General Technical Report NE-172.

Piva, R. and Jones, S. 1994. Missouri timber industry - an assessment of timber product output and use, 1994. USDA Forest Service, North Central Forest Experiment Station, Resource Bulletin NC-184, 54pp.

Randall, A. and Stoll, J. 1983. Existence value in a total valuation framework. pp. 265-274, in Rowe, Robert and Chestnut, Lauraine (eds.). Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas. Westview, Boulder.

Rothwell, R.L. 1978. Watershed management guidelines for logging and road construction in Alberta. Canadian Forestry Service, Northern Forest Research Centre, Alberta, Canada. Information Report NOR-X-208.

Scoles, S. et al. 1994. Forestry and water quality, a review of watershed research in the Ouachita Mountains. Oklahoma Cooperative Extension Service, Oklahomas State Univ. Circular E-932.

Sedjo, Roger et al. 1994. Global forest products trade: the consequences of domestic land use policy. Resource for the Future Discussion Paper. no. 94- 13.

Seehorn, M.E. 1986. The influence of silvicultural practices on fisheries management: effects and mitigation measures. In: Proceedings of Managing Southern Forests for Wildlife and Fisheries. South. For. Exp. Sta. USDA Forest Service. GTR SO- 6554-63. p. 54-63.

Settergren, C.D., Nugent, R.M., and G.S. Henderson. 1980. Timber harvest and water yields in the Ozarks. Symposium on Watershed Management. Volume 2. pp661-681.

Sidle, R.C. 1980. Impacts of forest practices on surface erosion. Pacific Northwest Extension Publication PNW-195, Oregon State Univ. Extension Service.

Smith, Danna. 1997. Chipping forests & jobs: a report on the economic and environmental impacts of chipmills in the Southeast. Dogwood Alliance, Brevard, North Carolina. 82pp.

Society of American Foresters, 1995. Reauthorization of the Clean Water Act, forestry effects on water quality. A Report to the Membership of the Society of American Foresters by the SAF Task Force on Reautorization of the Clean Water Act. 24 pp.

Spencer, J.S. Roussopoulos, S.M., and R.A. Massengale. 1989. Missouri forest resource, 1989: an analysis. USDA Forest Service, North Central Forest Experiment Station, Resource Bulletin NC-139, 84pp.

Swift, L.W., Jr. 1984. Gravel and grass surfacing reduces soil loss from mountain roads. Forest Science, 30(3):657-670.

Swift, L.W., Jr. 1986. Filter strip widths for forest roads in the Southern Appalachians. Southern Journal of Applied Forestry, 10(1):27-34.

Tennessee Valley Authority. 1993. Final environmenta impact statement chip mill terminals on the Tennessee River. TVA, Knoxville.

Thompson, F. R. and D. R. Dessecker. 1997. Management of early-successional communities in central hardwood forests with special emphasis on oaks, ruffed grouse, and forest songbirds. Gen. Tech. Report NC-195. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 33pp.

Titus, R. 1985. Management of snags and cavity trees in Missouri. Habitat Management Series 2. Missouri Dept. Conservation, Jefferson City. 21pp.

Varian, Hal. 1984. Microeconomic theory. North & Co., N.Y.

Waters, Thomas F. 1995. Sediment in streams sources, biological effects, and control. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, Maryland. pp24-36.

West, C. 1992. Competitive analysis of the global trade in hardwood chips. Proceedings, Southern Forest